SUMMARY OF FINDINGS

This report covers data collected at twenty sites, primarily in the northern Lake Washington basin. The objectives of this reporting effort was to: analyze data for long-term water quality trends; determine compliance with State and Federal water quality criteria; evaluate the level of metals in stormwater and sediments; compare baseflow with storm event sampling; and, to characterize the general water quality of the streams.

This chapter begins with a brief summary of findings, followed by a more detailed findings report, and ends with an analysis, and discussion.

Summary of Findings

There have been several significant trends in water quality parameters from 1979 to 1999. Due to natural variability of environmental data, these trends would not likely have been discernable over a shorter period of record. Significant long-term trends are summarized below.

- Dissolved oxygen concentrations have declined since 1990 at the mouth of Swamp Creek and at both monitoring sites on Evans Creek.
- Stream temperatures have shown an increasing trend at eighteen of the twenty sites between 1979 and 1999.
- pH has been decreasing since 1979 in Thornton Creek, the mouth of the Sammamish River, Swamp Creek, McAleer Creek, and at both sampling sites on Evans Creek.
- There has been an increasing trend in conductivity values at all sites except for upper Evans Creek from 1979 to 1999.
- Suspended solids have been decreasing under baseflow conditions on Little Soos Creek.
- In general, ammonia-nitrogen concentrations were higher in the fall and winter and have shown an increasing trend on the mainstem of Bear-Evans Creek, Cottage Creek, upstream Evans Creek, Covington Creek, and at the mouth of McAleer Creek since 1979.
- There has been an increase in nitrate concentrations at Covington and Jenkins Creeks in the Soos Basin since 1979.

- Fecal coliform bacteria levels decreased between 1979 and 1999 at sixteen of the twenty sites reported here, however, none of the sites in this report met state criteria for fecal coliform bacteria.

- Total phosphorus concentrations have decreased between 1979 and 1999 at Juanita Creek, the mouth of the Sammamish River, Swamp Creek, and North Creek, several sites in the Bear-Evans Creek, Cottage Creek, and the mouth of Evans Creek.

Findings Report

Dissolved oxygen concentrations have declined since 1990 at the mouth of Swamp Creek and at both sites on Evans Creek. The highest number of state criteria violations for dissolved oxygen concentrations were measured at these two creeks. Most of these violations occurred during the summer dry season, implicating low flows and high temperatures as the primary factors influencing the low oxygen concentrations. Greater than 95 percent of the dissolved oxygen samples at all of the other stream sites were above the State standard of 9.5 mg/L. Storm samples collected at the mouth of Swamp Creek violated dissolved oxygen criteria in three of the 26 samples. The reason for this declining trend is undetermined. Although concentrations of dissolved oxygen at these two sites remains lower than most other sites, time series plots indicate concentrations may be increasing again, though not yet at levels considered statistically significant.

Stream temperatures have shown an increasing trend at eighteen of the twenty sites between 1979 and 1999. Increases may be associated with removal of riparian vegetation and increasing impervious surfaces due to urbanization, or changes in regional climate conditions.

Suspended solids have been decreasing under baseflow conditions on Little Soos Creek. This decline in suspended solids may be the result of changes in land uses a short distance upstream of the sampling site where small hobby farms no longer keep livestock near the creek. Poor animal keeping practices can result in the destruction of riparian buffer zones and increased sediment and fecal matter washing into surface waters.

pH has been decreasing since 1979 in Thornton Creek, the mouth of the Sammamish River, Swamp Creek, McAleer Creek, and at both sampling sites on Evans Creek. Increased urbanization and the resulting increased stormwater runoff may have contributed to this decline in pH. Low pH can promote other water quality such as increased solubility of metals and increased

toxicity at lower pH values. At lower pH values, nutrients are more soluble and more readily available to phytoplankton and aquatic plants.

Conductivity values have increasing at all sites except for upper Evans Creek from 1979 to 1999. These increases are likely a result of increased urbanization.

Ammonia-nitrogen concentrations, in general, were higher in the fall and winter and have shown an increasing trend on the mainstem of Bear-Evans Creek, Cottage Creek, upstream Evans Creek, Covington Creek, and at the mouth of McAleer Creek since 1979. No cause for the increase was determined.

Nitrate+nitrite- concentrations are highest in the winter. There has been an increase in nitrate concentrations at Covington and Jenkins Creeks in the Soos Basin since 1979. No cause for the increase was determined.

Total phosphorus concentrations have decreased between 1979 and 1999 at several sites; Juanita Creek, the mouth of the Sammamish River, Swamp Creek, and North Creek, several sites in the Bear-Evans Creek, Cottage Creek, and the mouth of Evans Creek. Increased implementation of "best management practices" (BMPs, e.g., erosion control during construction, etc.) may be a contributing factor to the decrease in concentrations.

Ortho-Phosphorus concentrations, in general, are higher April through August. Between 1979 and 1999 there was a decrease in ortho-P concentrations at the mouth of the Sammamish River and at North and Swamp Creeks. As with total phosphorus, implementation of best management practices may be resulting in lower measured concentrations.

Fecal coliform bacteria levels decreased between 1979 and 1999 at sixteen of the twenty sites reported here, though none of the sites in this report met state criteria for fecal coliform bacteria. The most dramatic decrease was measured at North Creek, Little Soos Creek, and the mouth of Bear Creek. Implementation of best management practices as well as changes in land use from hobby and commercial farming may have resulted in lower bacteria counts. Studies in urbanized Thornton Creek have identified humans as a source of the fecal bacteria, but not a major source to the very high counts common in this stream.

Trace metals in both the water and the sediments usually met the EPA criteria when the comparisons could be made. Relatively high detection levels for past analytical techniques made

comparisons to the criteria impossible. Current analytical methods have lower detection limits that allow for better comparisons to criteria and trend analysis in the future.

Analysis and Discussion

A recent Puget Sound lowland stream study concluded that physical, chemical, and biological characteristics of streams change with increasing urbanization in a continuous rather than a threshold fashion (May et al., 1997). It was found that the altered watershed hydrologic regime was the leading cause for the overall changes observed in instream physical habitat conditions. In contrast to the physical habitat, water quality constituents and sediment metal concentrations did not follow this pattern, changing little until the urbanization gradient approached 40 % total impervious area (% TIA). Even then, the water column concentrations did not violate state and federal aquatic life criteria and sediment concentrations remained far below guidelines. After the extent of urbanization exceeded 50 % TIA, most pollutant concentrations rose rapidly, and their role become more important biologically.

Since 1976 the water quality measured at most County sites has been affected by development as indicated by increases in temperature and conductivity, and decreases in pH. It may be that some of the impacts resulting from increased land development in the last two decades have been mitigated by improved implementation of various BMPs as indicated by the observed decreasing trends in total phosphorus and fecal coliform bacteria.

However, the use the water quality constituents and sediment concentrations may not be the most appropriate indicators to use when trying to quantify impacts to the streams from urbanization. If the role of pollutant concentrations becomes measurably important to the biological integrity of a stream only after the % TIA reached 50 percent (May et al., 1997), then the full extent of urbanization on concentrations of chemical constituents in many of King County streams may not yet be fully realized.

The timing and extent of land-use changes impact water quality, biological indicators of stream health. The timing and extent of land use change helps to interpret long-term trends in water chemistry (i.e., declines in phosphorus and fecal bacteria due to upgraded infrastructures and reduction of hobby farms) and potential impacts to the biota. Geographically explicit temporal mapping of each stream basin showing the changes in percent impervious area needs to be done for each sub-watershed. Including benthos data along with stream habitat, percent total impervious area, and water quality chemistry will provide a better indication of the overall biological integrity of the stream, and identify stressors to impacted streams.

Trace metals have not been shown to be a widespread problem in the streams covered in this report. Comparisons to state and federal criteria were not possible due to the relatively high detection limits of analytical techniques used until 1993. Current analytical methodologies have much lower detection limits and will allow for better comparisons. As the length of the data record increases, trend analysis for metals in water and sediment can be included.

There was an increase in water temperature from 1979 to 1999 at nearly all of the sites included in this report. It is difficult to determine whether this trend is the result of urbanization, regional climatic cycles, degradation of the riparian zone, or a combination of these factors. The Puget Sound Lowland study (May et al., 1997) found that a key determinant of the biological integrity of a stream appears to be the quality and quantity of the riparian zone available to buffer the stream ecosystem from negative influences in the watershed. Comprehensive habitat assessments of major tributaries should be prioritized and completed as was done for with the Habitat Inventory and Assessment for North, Swamp and Little Bear Creeks (King County WLRD, 2001) and Juanita Creek (King County WLRD report due in spring 2002). These assessments determine the extent of riparian vegetation and impervious area in the drainage basin. This work should be coordinated with other habitat assessment groups. Likewise, regional climatic cycles should be evaluated to determine their influence of any observed water quality trends.

None of the sites in this report met the state criteria for fecal coliform bacteria. Other work suggests most of the fecal material found in surface water is often related to increased development and the subsequent increases in the localized density of pets. In addition, poor animal keeping practices are known to increase bacteria levels in soil and surface waters. In some locations, the primary bacteria sources are waterfowl whose populations have increased dramatically in recent years. Source tracing should be carried out at several, if not all of the sites with chronically high bacterial counts.

Preliminary source tracing was conducted in the Thornton Creek, McAleer Creek, and Lyon Creek watersheds in 2001, and as part of that effort a microbial source tracking survey was conducted in the Thornton Creek watershed. Similar to what was found in Juanita Creek in 1998, the preponderance of identifiable bacterial isolates was traced to birds and dogs. However, about 3 percent of the *E. coli* isolate matches were to humans, unlike the Juanita Creek survey, which had no matches to human sources.

Bacterial contamination is a major water quality issue for King County that is not limited to the streams in this report. While the identified load from human sources are a far smaller than from

other animal sources, the public health implications are far greater, and represent the greatest challenge to restoring the natural environment and protecting public health and safety. Bacterial contamination from non-human sources also has public health concerns, and indicates non-point pollution sources. If pollution sources are identified, corrective actions can potentially be carried out to reduce the impact to regional water quality.

The key issue facing King County streams as cited in the 1978Area wide Water Quality Plan and the 1987 Priorities for Water Quality Report- "that of aquatic habitat degradation" is still a key issue today. Much research since 1979 has focused on stormwater management and impacts to streams due to increased urbanization. In particular, the Puget Sound Lowland stream study found "that there is a set of necessary, though not by themselves sufficient, conditions required to maintain a high level of stream quality or ecological integrity. If maintenance of that level is the goal, then this set of enabling conditions constitutes standards that must be achieved if the goal is to be met" (May et al., 1997). For most County streams, imperviousness must be limited (<5 – 10% TIA), unless mitigated by extensive riparian corridor protection and stormwater management. Otherwise we will need to acknowledge that fish runs will disappear, water quality will degrade, and probability of flooding will increase. Downstream changes to both the form and function of stream systems are inevitable unless significant changes are made in the way urban development occurs. King County adopted more stringent stormwater management requirements in 1998 with the adoption of the King County Surface Water Design Manual. There are some indications that these requirements have been effective in mitigating some of the impacts of urbanization. But there are also indications that these efforts are insufficient to correct many of the impacts and protect the natural environment and public health and safety.